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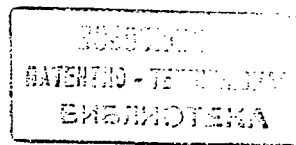
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(58) Field of search

C7F

C7U

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(54) Ion assisted coating process

(57) A process for forming a coating upon a substrate comprising the operations of depositing upon the substrate alternate layers of a material e.g. Ti capable of forming a relatively ductile nitride or carbide and a material e.g. B capable of forming a relatively hard nitride or carbide and subjecting the layers of the said materials to bombardment with ions of nitrogen and/or carbon so as to form the said nitrides or carbides. Improved adhesion and resistance to cracking is achieved.

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SPECIFICATION

Ion assisted coatings

5 The present invention relates to the formation of coatings on surfaces by methods which include the bombardment of the surfaces with ions, and more particularly to processes which combine ion bombardment with other techniques for depositing coatings on surfaces.

10 Such combined processes, which are known as ion assisted coating, ion beam enhanced deposition or ion vapour deposition, are used to produce coatings which will protect the substrate surface against corrosion or wear, or to produce other desired qualities such as coloration or other decorative effects.

15 Two materials which have been used to prepare such coatings are titanium and boron, both of which can be converted to nitrides by bombardment with nitrogen ions during or after their own deposition, usually by some other in vacuo technique such as electron beam evaporation or sputtering. It is found
25 however that films of titanium nitride formed by the deposition of titanium and nitrogen ion bombardment have good adhesion to steel substrates but are relatively soft, often being little harder than the steel substrate and have appreciable ductility. Similarly formed boron nitride films on the other hand are much harder, more than an order of magnitude harder than steel, but are brittle and tend to fail by cracking when they are put under load, especially
35 when they are under tension as at, for example, the edge of an indentation.

According to the present invention there is provided a process for forming a coating upon a substrate comprising the operations of depositing upon the substrate alternate layers of a material capable of forming a relatively ductile nitride or carbide and a material capable of forming a relatively hard nitride or carbide and
40 subjecting the layers of the said materials to bombardment with ions of nitrogen and/or carbon so as to form the said nitrides or carbides.

The ion bombardment may be carried out simultaneously with the deposition of the said material, or sequentially therewith.

Suitable materials are titanium to form the relatively soft nitride (or carbide) and boron to form the relatively hard nitride (or carbide).

55 If it is desired to produce a wear resistant coating, then, preferably, the first deposited layer should be of titanium and the last deposited layer should be of boron.

In one process according to the invention, alternate layers of titanium and boron are deposited by means of electron beam evaporation upon a metal substrate to be protected with simultaneous bombardment by nitrogen ions having energies in the range 1 to 100 KeV. The ion dose is chosen to be such that
65 at least 10% of the material of each layer of

titanium or boron is converted to the appropriate nitride. Depending on the application for the substrate, the thickness of the layers of titanium and boron can be between 0.1 and 200 n.m. although a preferred range is between 1 to 10 n.m.

70 Although the composite coating material will consist of alternate layers of titanium and boron, at the interfaces between the layers there will occur both a measure of ion beam mixing and solid state reactions which will produce regions of titanium borides. These will both facilitate the adhesion between successive layers of titanium and boron nitrides and arrest cracks which may occur under conditions of stress. Also, as it is arranged that not all the titanium is converted to the nitride, the titanium layers consist of titanium metal with a very high concentration of small (~10 n.m.) precipitates of titanium nitride, so as to provide a cermet material which has toughness and deformability in addition to good wear resistance.

In a variation of the process, the titanium layers may be made to contain aluminium, and the boron layers carbon.

CLAIMS

1. A process for forming a coating upon a substrate comprising the operations of depositing upon the substrate alternate layers of a material capable of forming a relatively ductile nitride or carbide and a material capable of forming a relatively hard nitride or carbide and
100 subjecting the layers of the said materials to bombardment with ions of nitrogen and/or carbon so as to form the said nitrides or carbides.

2. A process according to claim 1 wherein the ion bombardment is carried out simultaneously with the deposition of each layer of the said materials.

3. A process according to claim or claim 2 wherein the material to form the relatively soft nitride or carbide is titanium and the material to form the relatively hard nitride or carbide is boron.

4. A process according to claim 3 wherein the first deposited layer is of titanium and the final deposited layer is of boron.

5. A process according to any preceding claim wherein the ion bombardment is carried out with nitrogen ions having energies in the range 1-100 Kev and the ion dose is such that at least 10% of the material of each layer is converted to the appropriate nitride.

6. A process according to claim 4 or claim 5 wherein the titanium layers also contain aluminium and the boron layers carbon.

7. A process for forming a coating upon a substrate substantially as hereinbefore described.

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